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XXIV.—*The Genus Acinetoides, g. n., an Intermediate Form between the Ciliated Infusoria and the Acinetæ.* By Dr. L. PLATE\*.

[Plate X., A.]

IN the spring of 1886 I found upon colonies of *Zoothamnium* from the Bay of Naples two peculiar, still undescribed Suctoria, which are of some interest because they remain throughout life in the same stage of development which is represented in other Acinetæ by the freely motile buds. They justify the conclusion expressed in the title of this article, that we have here to do with an animal-form which combines in itself some of the characteristic features of the Ciliated Infusoria and the Acinetæ. The two species which have come under my observation in Naples may in future be united under the generic name *Acinetoides*, which at the same time indicates that the Protozoa in question in their general habit nevertheless are more nearly allied to the Suctoria than to the Ciliata.

\* Translated from the 'Zoologische Jahrbücher, Abth. für Anatomie und Ontogenie der Thiere,' Band iii. pp. 135-143 (May 1888).

Figure 1 (Pl. X., A) represents the larger of the two species, which I venture to name *Acinetoides Greeffii*, in honour of Prof. R. Greeff, to whom we are indebted for various valuable investigations upon Protozoa. The animal attains a length of 0.046 millim. and an elevation of 0.02 millim. In form it greatly reminds us of the swarm-buds of many *Acinetæ*, for example *Dendrocometes paradoxus*, St., but the arrangement of the cilia is quite different. *Acinetoides Greeffii* has a plano-convex form. Seen from above or below (fig. 2) the animal shows an elliptical outline; the convex surface of our Infusorian may be denominated the back, and the flat one the belly. The latter is seldom quite plane, but generally hollowed out like a basin, as shown in fig. 1. Only one end of it, which we shall regard as the anterior, usually makes an exception to this, and projects beyond the ventral margin of the body in the form of a low cone, bearing in its middle the organ for the inception of nourishment, a sucking-thread clubbed at the extremity, which may be traced far into the interior of the cell-body and is distinguished only by its remarkable shortness and rigidity from the similar organs of most other *Acinetæ*; at least I have never found specimens which had completely retracted their tentacle into the cell-plasma; but even in greatly disturbed animals this short sucking-thread was always visible. Of the minute structure of this organ I was unable to ascertain much, owing to the want of high objectives; it appeared to me to be a plasma-rod traversed by a longitudinal canal.

The persistent ciliation of the ventral surface is highly characteristic of the genus *Acinetoides*. It does not extend over the whole lower surface, but, as may be seen by an inspection of the ventral surface (fig. 2), only occupies an elliptical inner area, leaving the whole peripheral border free of cilia. The cilia are arranged in longitudinal rows, and appear to stand in special grooves; at least we observe upon the ventral surface a delicate longitudinal striation which extends over an area of exactly the same size as the cilia. Each stria consists of granules lying one behind the other, and thus produces about the same impression as the rows of granules in *Stentor*, between which the myophanic fibrils take their course. I have been unable to detect in *Acinetoides* any threads which might represent the latter, although it is quite certain that the ventral surface of *Acinetoides Greeffii* possesses a high degree of contractility; I suppose therefore that an examination by means of very powerful objectives may reveal the presence of muscular fibrils in our animal also. By means of this contractility it is able some-

what to modify its form, and especially to render the convexity of the dorsal surface sometimes quite hemispherical, sometimes much flatter. Further on, in describing the mode of life of our Infusoria, I shall come back to this and indicate the use which the species of *Acinetoides* make of this faculty.

*Acinetoides Greeffii* is bounded externally throughout by a thin cuticle. The interior of the cell-body is destitute of any special peculiarities. We find in it an elongated nucleus, often curved into the form of a sausage (fig. 1, N), which extends through almost the whole cell, possesses a finely granular structure, and is enclosed by a special membrane; and, further, numerous granules of fatty lustre, and a contractile vacuole situated close to the ventral surface (figs. 1, 2, cv.).

The second species of the genus, which, from its dwelling-place, may bear the name of *Acinetoides zoothamni*, resembles that above described in nearly all points. It is, however, considerably smaller, namely about half the size of *A. Greeffii*, and it possesses a nucleus of different form, spherical and of comparatively very small size.

The specific difference of the two Infusoria just noticed is also distinctly recognizable in their mode of life. Common to both is that they reside upon colonies of the Vorticelline genus *Zoothamnium*, and feed by sucking out the individuals of their colonies. They are therefore parasites and become exceedingly injurious to the elegant structures in question. I have often met with bushes of them which, on some branches, had lost all the individuals by the *Acinetoides* which swarmed around them. It is remarkable that each species of *Acinetoides* attaches itself to a definite region of the body of a *Zoothamnium*. The individuals of *Acinetoides Greeffii* always select the base of the animal on which they prey at the point where the muscle of the contractile stem radiates in a tuft into the bell (fig. 3), and they fix themselves here by bending the body transversely in the middle, and thus attach themselves closely to their victim. Evidently they are enabled to do this only by the great contractility of the ventral surface, seeing that the attachment is effected by the production of a vacuum within the basin-like ventral surface. While the plasma of the Vorticelline flows over into the *Acinetoides*, the cilia of the latter are in general quite quiet; sometimes, however, for a few moments they move again, wholly or partially, a proof that in the attachment only the peripheral border of the ventral surface of our Suctorian is adherent to the prey. In this position the *Acinetoides* often remains for a considerable time—an hour or more—but fre-

quently only for a few minutes. Shortly before the separation the cilia begin to work more vigorously, the animal moves a little to and fro, nay, it sometimes rotates around the sucking-tube, which is still inserted in the prey, and finally separates entirely from its victim. Its movements while swimming freely about are very irregular and exactly resemble the spasmodic movements of the buds of *Acinetæ*. I have frequently observed that within about a minute of their separation the animalcules had attached themselves again.

*Acinetoides Greeffii* is so large that only two individuals can find room at the same time upon a *Zoothamnium*, as the species always selects the base of the bell for fixation. It is otherwise, however, with the smaller species. This avoids the neighbourhood of the peduncle and attaches itself by preference to the peristomial region or the sides of the body; and in consequence of its small size we often see from three to five individuals occupied at the same time in sucking out the same *Zoothamnium*. The death of the latter occurs very soon after the attachment of an *Acinetoides*, so that this evidently brings its prey in contact with some corrosive fluid. The loss of substance which the *Zoothamnium* thus suffers causes the collapse of the anterior part of the bell, the cuticle of which falls into numerous wrinkles and folds. It is remarkable that the animalcules never completely exhaust their victims (even when several of them prey upon the same individual), but they confine themselves to a portion of the plasma and then fall upon another Infusorian. The only probable reason of this is that the body-substance of the *Zoothamnium* is altered by long action of the destructive fluid secreted by the *Acinetæ*, and then no longer suits the taste of our animalcules.

As to the reproduction of the genus *Acinetoides*, I could learn nothing except from the smaller species. Of course a thorough knowledge of this is of the greatest importance, seeing that without it there is always a possibility that the Protozoa described are only swarm-buds of other Suctoria, as they are distinguished from these only by the presence of a *single sucking-tube*. That such a supposition was incorrect was indeed quite clear to me from the first, as I always observed the *Acinetoides* in great numbers together, and on the colonies of *Zoothamnium* attacked by them there were in addition only a few *Podophryæ*, which were smaller than the Suctoria here described, and therefore could not possibly be connected with them. Moreover the swarming-buds of these *Podophryæ* also occurred; they had quite a different form of

body from the species of *Acinetoides*, and, further, possessed no sucking-tentacle. The conclusion that these were independent organisms, and not mere developmental forms, was therefore unavoidable, and it was afterwards confirmed by the observation of the reproduction of *Acinetoides zoothamni* by simple transverse fission. The individuals in course of division sometimes swam about and sometimes remained seated upon their food-animals; but I did not succeed in the latter case in observing a double sucking-tentacle.

The reproduction by transverse division furnishes a further proof of the intermediate position which the genus *Acinetoides* occupies between the Ciliata and the Suctoria. Such a mode of reproduction has indeed already been observed in various other Acinetæ, as in *Podophrya fixa*, *Acineta mystacina*, *Urnula epistylidis*, and some others; but it is nevertheless a rare mode of increase among the Suctoria, quite subordinate to the reproduction by external or internal budding; while, on the contrary, among the Ciliata the new individuals in general originate by transverse or longitudinal division, and are produced as buds only in some attached genera. This contrast, as regards reproduction, which exists between the Ciliated Infusoria and the Acinetæ is not principal, but only caused by the different mode of life. With respect to the possibility of nourishment, a sessile organism is always at a disadvantage as compared with one of the same structure but capable of free locomotion, and therefore for the continuance of its species requires a larger progeny, a purpose which is of course better attained by the formation of numerous small buds than by simple division, which furnishes only two descendants from one parent-animal.

What systematic position the genus *Acinetoides* has to occupy cannot be doubtful after what has been said; it is to be referred to the Suctoria and to be regarded as a transition-form between these and the Ciliated Infusoria. *The existence of such an intermediate form, it appears to me, furnishes a fresh argument in support of the opinion already maintained by several naturalists, that the Acinetæ are modified Ciliata, which have acquired peculiar sucking and grasping filaments, to be regarded as organs sui generis, in connexion with the acquisition of a sessile or parasitic mode of life. This notion is founded principally upon the fact that the buds of the Acinetæ resemble the true Infusoria in their holo-, hypo-, or peritrichous coat of cilia, so that the Acinetæ in their youth pass through a ciliatiform stage. It has been urged against this conception of the swarm-buds (I think erroneously) that the so-called "biogenetic fundamental law" is not applicable*

to unicellular organisms, and therefore the free mobility of the Acinetan offshoots must be regarded as a special phenomenon of adaptation. If there is really the tendency in the organism to recapitulate in its ontogeny certain morphological conditions which correspond in their sequence with the phylogenetic development, it is a matter of no consequence whether these conditions are displayed by *one* cell or by a cell-complex. In the formation of buds in which the parent and its offspring are even externally of such different structure, the micellar structure of the plasma in the bud will very probably also differ from that of the parent; and it is quite conceivable that the former agrees approximately with the plasmatic structure proper to the ancestors of the Infusorian under consideration, and therefore the biogenetic law may also apply to the developmental history of the bud. This is impossible only when a Protozoon divides into two portions which behave exactly alike both as regards their external characters and in their further phenomena of growth; this, however, is not the case in multiplication by buds. Suctoria of the nature of the genus *Acinetoides* can be naturally referred only to Ciliated Infusoria (whether directly or by the derivation of both families from a common stock), and therefore the view, which Maupas \* has recently supported, that the Acinetæ are more nearly allied to the Rhizopoda, and especially to the Heliozoa †, seems to me not to be correct. For if the sucking-organs of the Suctoria have really proceeded from Rhizopod pseudopodia, these ought always to be present in considerable number, whereas in *Acinetoides* only *one* such tentacle occurs. For the maintenance of Maupas's conception, therefore, we must assume a reduction in the number of tentacles for the genus just mentioned, a hypothesis which it is difficult to reconcile with its other primitive characters. In support of his hypothesis Maupas ‡ cites a statement of Engelmann's according to which the cilia in the lower plants and animals are so diffused that in phylogenetic investigations no value is to be attached to their presence or absence. I believe that the above-mentioned naturalists go rather too far in their deductions. It is certainly true that organs which, like the cilia or eye-pigment-spots, recur in the most various classes, are to be very cautiously made use of in phylogenetic questions; but they are certainly not therefore wholly without significance, for even their arrangement and position are governed by heredity. It is only in this way explicable that

\* "Contribution à l'étude des Acinéliens," in Arch. de Zool. Expér. tome ix. (1881), pp. 299-368.

† *Ibid.* p. 367.

‡ *Ibid.* p. 363.

nearly allied *Acinetæ* frequently have swarm-buds with a ciliation arranged in the same or a similar manner, of which the Suctorian described in the next article, whose nearest ally is undoubtedly *Dendrocometes paradoxus*, furnishes a good example. We may therefore justly conclude from the ciliary clothing of the Acinetan buds that the Suctorina are genealogically connected with the Ciliata, a conclusion which is the more naturally arrived at because we know many Ciliated Infusoria which have lost their buccal aperture by adaptation to peculiar conditions of life.

In *Sphaerophrya magna* Maupas\* has detected tentacles which greatly resemble the pseudopodia of the Rhizopoda. They are contractile rods composed of a plasmatic axis and a cortical layer, and therefore are not hollow, and are not continued into the proper body of the Acinetan. They terminate in a knob which very quickly kills and then holds fast such Infusoria as may come in contact with it. Then the tentacle increases greatly in thickness, which Maupas, probably with justice, places to the account of an invisible current of plasma flowing out from the Suctorian to the prey and probably penetrating into it. Finally a current in the opposite direction is observed, which conveys the plasma of the captured animal to the body of the *Sphaerophrya*. The inception of nourishment therefore takes place here in exactly the same manner as with true pseudopodia, namely without any pumping movement. Such organs, however, are by no means characteristic of the whole class of the *Acinetæ*, but are at present known only in that single form. Specially peculiar to the Suctorina are the "sucking-tubes," plasma-rods traversed by a canal, which generally originate far within the cell-body and extract the nourishment from the prey by a pumping movement. In most genera we find only such structures, which can be referred back neither to the cilia of the Ciliata nor to the pseudopodia of the Heliozoa, but are to be regarded as organs *sui generis*; from these, in a higher grade of differentiation, have proceeded in the first place those pseudopodium-like tentacles, and in the second the grasping-threads, which serve only for seizing the prey, and the investigations into the structure of which are not yet concluded. In *Podophrya gemmipara* R. Hertwig ascribes to them a solid structure, while Maupas states that he has found a canal in their interior.

The latter naturalist has indicated † that nucleoli are at present known only in certain Ciliata and some Suctorina, but

\* *L. c.* p. 300 *et seqq.*

† *L. c.* p. 364.

have not been found in Rhizopoda; and this circumstance is in favour of the old theory to which I have here endeavoured to give further support.

Lastly, it may be mentioned that in the process of conjugation homologies between Acinetæ and Ciliata may be demonstrated. In *Dendrocometes paradoxus*, for example, as I have shown in a previous memoir\*, the nucleus at the commencement of this process grows into a long filament and then breaks up into numerous pieces, just as is known to be the case in many Ciliated Infusoria (e. g. *Paramæcium aurelia* and *putrinum*). The Suctorian which will be fully described in the following article displays a further interesting stage of conjugation, which at present can only be compared with a similar one of *Paramæcium aurelia*. However, we are still too imperfectly acquainted with the conjugation of the Acinetæ to be able to deduce genealogical relationships from it.

#### EXPLANATION OF PLATE X., A.

Fig. 1. *Acineta Greeffii*, from the side.

Fig. 2. The same, from beneath.

Fig. 3. The same, two individuals attached to *Zoothamnium*.

The letters have the same signification in all, namely:—N, nucleus; t, tentacle; cv., contractile vacuole.

#### XXV.—*Asellicola digitata*, Stein's "*gefingerte Acinete*." By Dr. L. PLATE †.

[Plate X., B.]

THE *Acineta* described in the following pages is a near relative of *Dendrocometes paradoxus*, St., and lives upon the branchial plates of *Asellus aquaticus*; it is generically distinct from all Suctoria at present known, and I propose for it the generic name of *Asellicola*, in allusion to the place of its occurrence. I have selected the specific name *digitata* because the distinguished naturalist F. von Stein very clearly described and figured it in his first great publication on the

\* "Untersuchungen einiger an den Kiemenblättern des *Gammarus pulex* lebenden Ektoparasiten," in Zeitschr. f. wiss. Zool. Bd. xliii. pp. 175-241.

† Translated from the 'Zoologische Jahrbücher, Abth. für Anatomie und Ontogenie der Thiere,' Band iii. pp. 143-155 (May 1888).